

Starstim EEG monitoring during tACS stimulation

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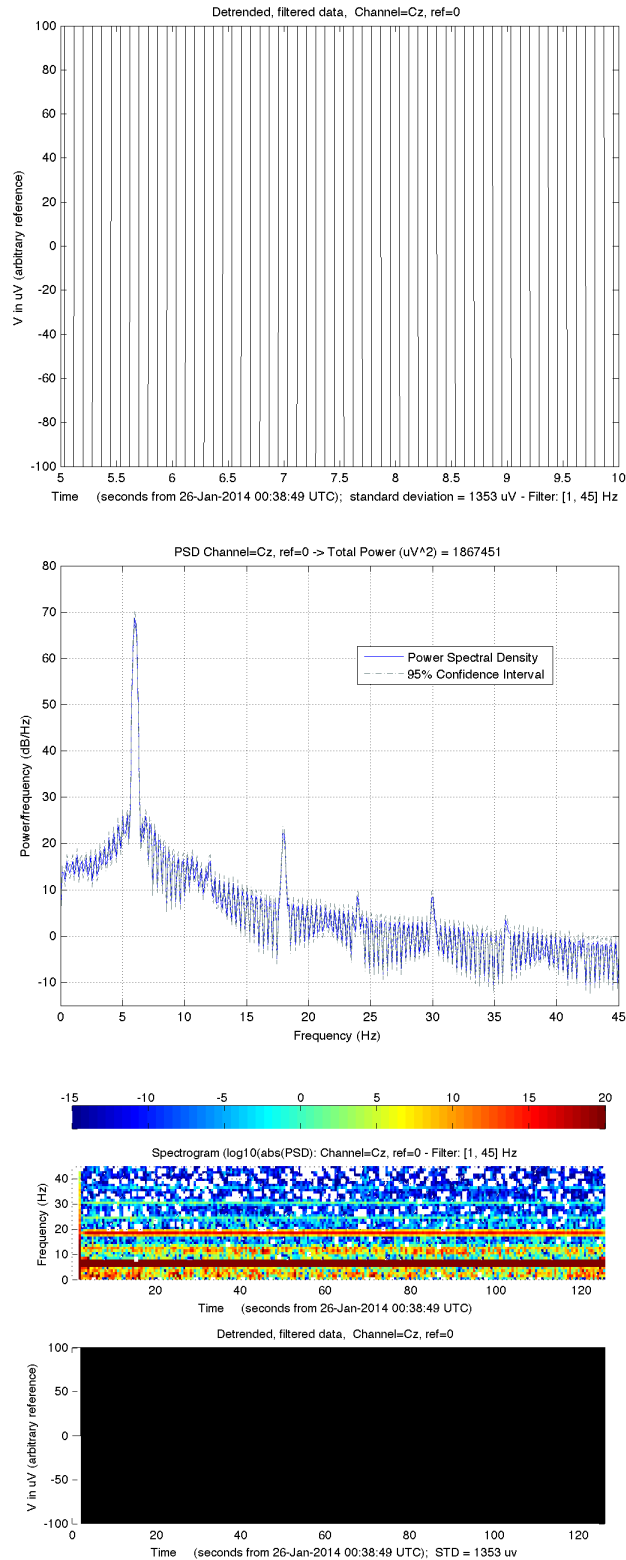
(January 22nd 2014)

In this short paper we provide an example of how EEG signals can be recorded with concurrent tACS stimulation with *Starstim* and *PISTIM* (gelled Ag/AgCl 3.14 cm²) electrodes. We recall here that Neuroelectrics *PISTIM* (or “Pi”) electrodes rely on optimal electrochemistry for efficient, focal and low noise current transfer. In particular, these electrodes are superior to sponge electrodes in terms of induced noise. See our [wiki](#) for more information.

In this test, stimulation currents were delivered to the scalp through electrodes located at F3 and F4 with different intensities and frequencies. *PISTIM* electrodes were used both for stimulation channels and EEG recording channels. CMS/DRL electrodes were placed in the right mastoid. As seen in the figures, the Power Spectral Density (PSD) of the EEG contains a clear frequency peak at 10 Hz and its harmonic at 20 Hz, corresponding to the alpha waves of the subject, who remained with eyes closed during the protocol. After dividing the signals into epochs, the fundamental stimulation frequency and its harmonics were successfully filtered using dynamic least squares fitting based on a nominal frequency template. For graphing purposes, signals are filtered from 1 to 45 Hz.

The figures in the following pages display detrended but otherwise raw EEG data, the spectrograms and the PSD functions of EEG signals from Cz and O2 electrodes recorded before and during tACS stimulation (before and after tACS artifact cleaning), highlighting the good quality of EEG data after artifact processing. Note that the tACS artifact in Cz position has been completely removed, even if this electrode is next to the stimulations electrodes (F3 and F4 in this case).

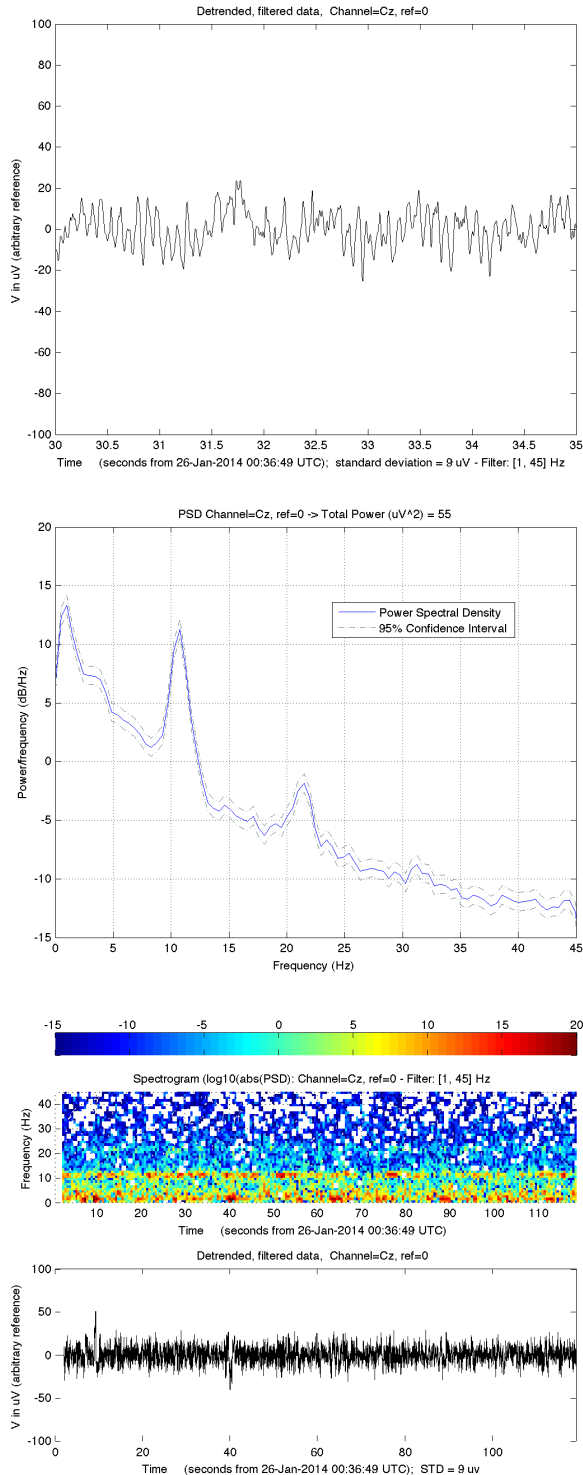
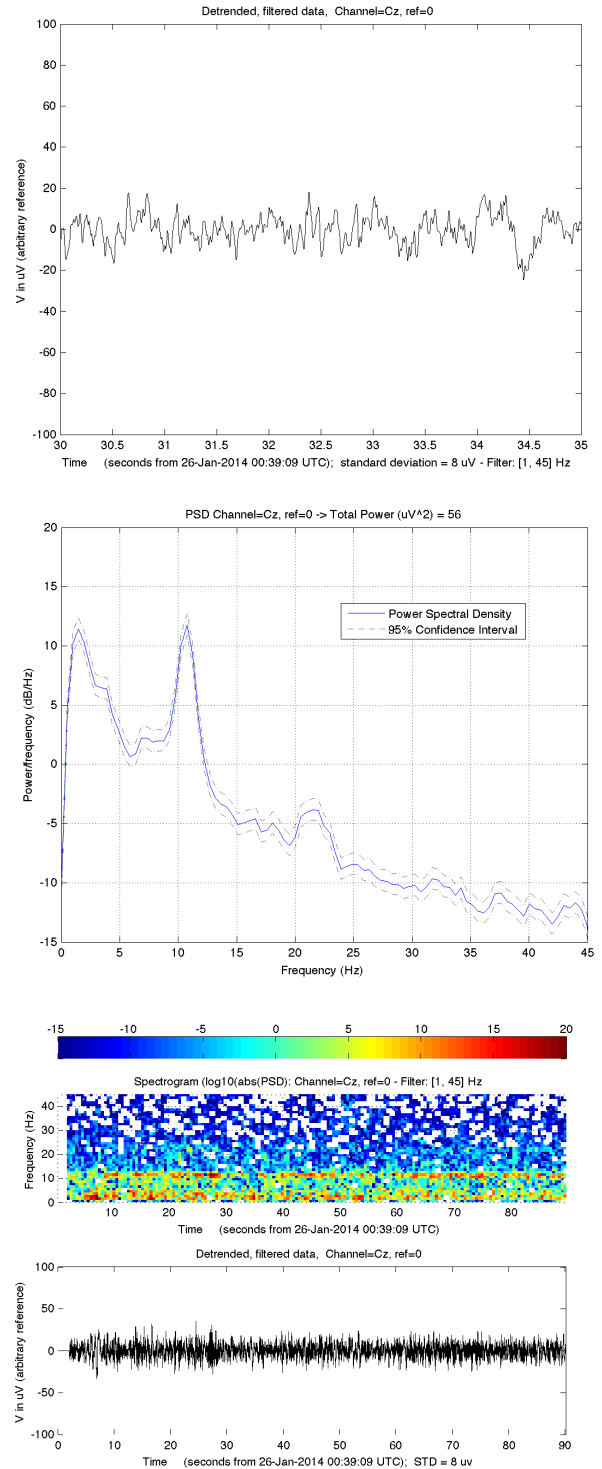
Using *PISTIM* electrodes thus opens the door to recording EEG signals during tACS and tDCS, as well as TMS as already discussed in previous [White Papers](#).



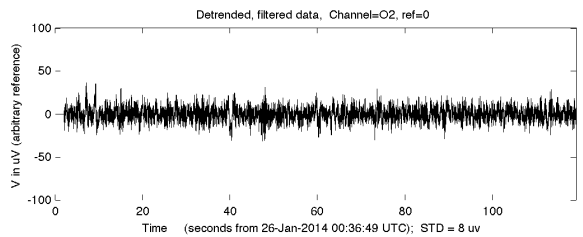
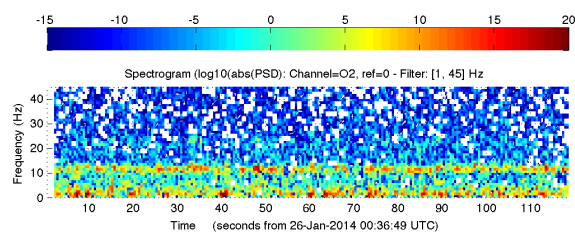
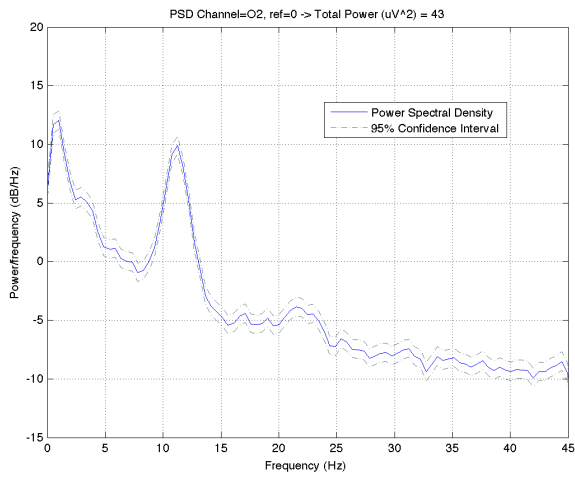
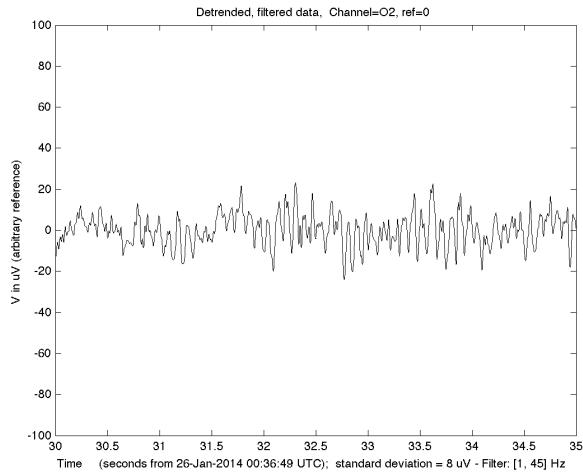
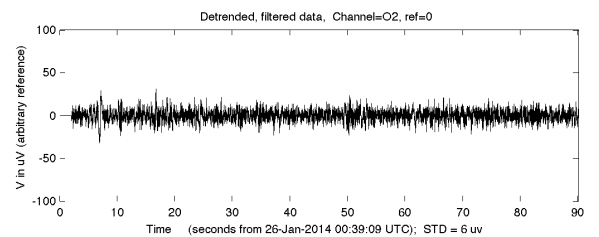
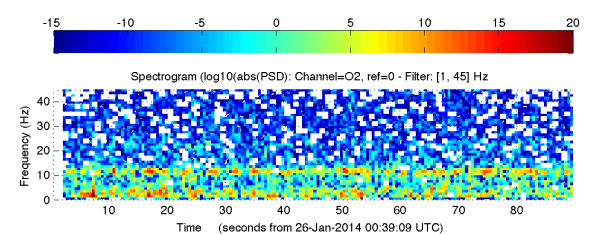
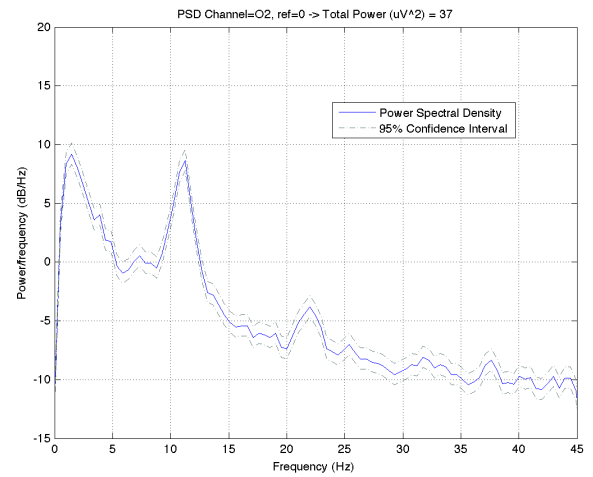
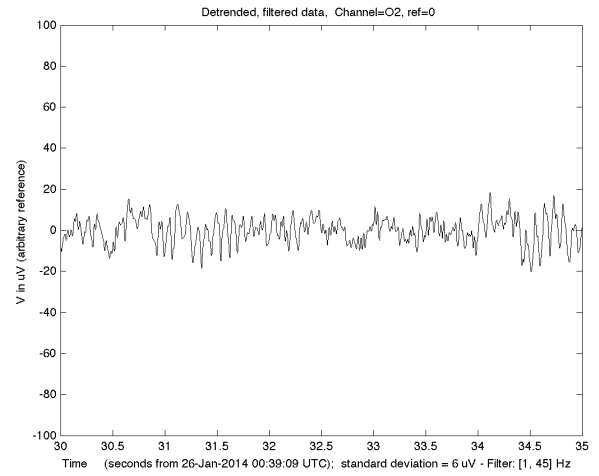
Time signal, spectrogram and Power Spectral Density function for Cz during stimulation at 6 Hz before cleaning the tACS artifact and its harmonics. The signals for the rest of the channels are almost identical. These figures are provided for comparison with the cleaned signals in the following pages.

Cz

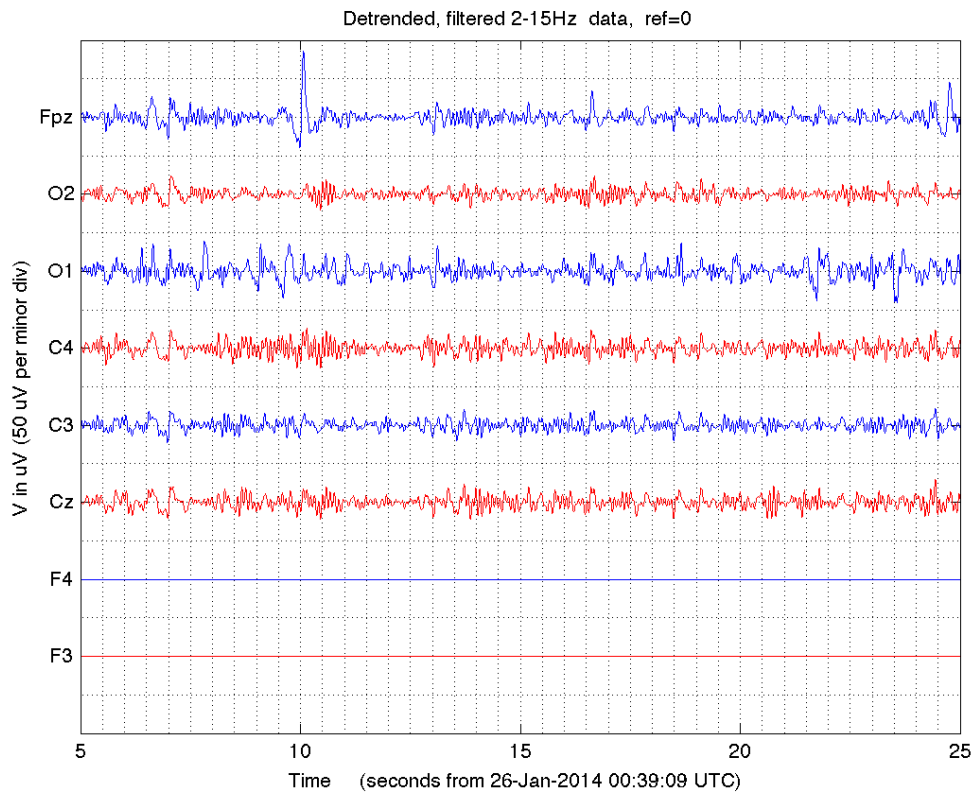
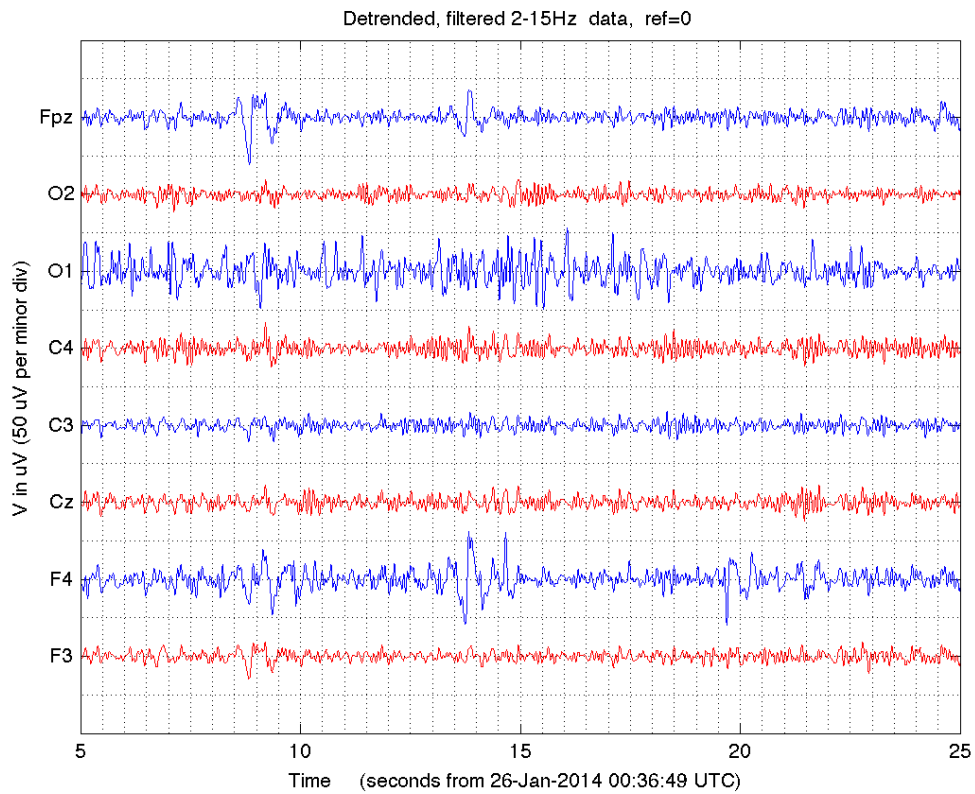
STIM OFF

STIM ON (6 Hz, 300 μA)

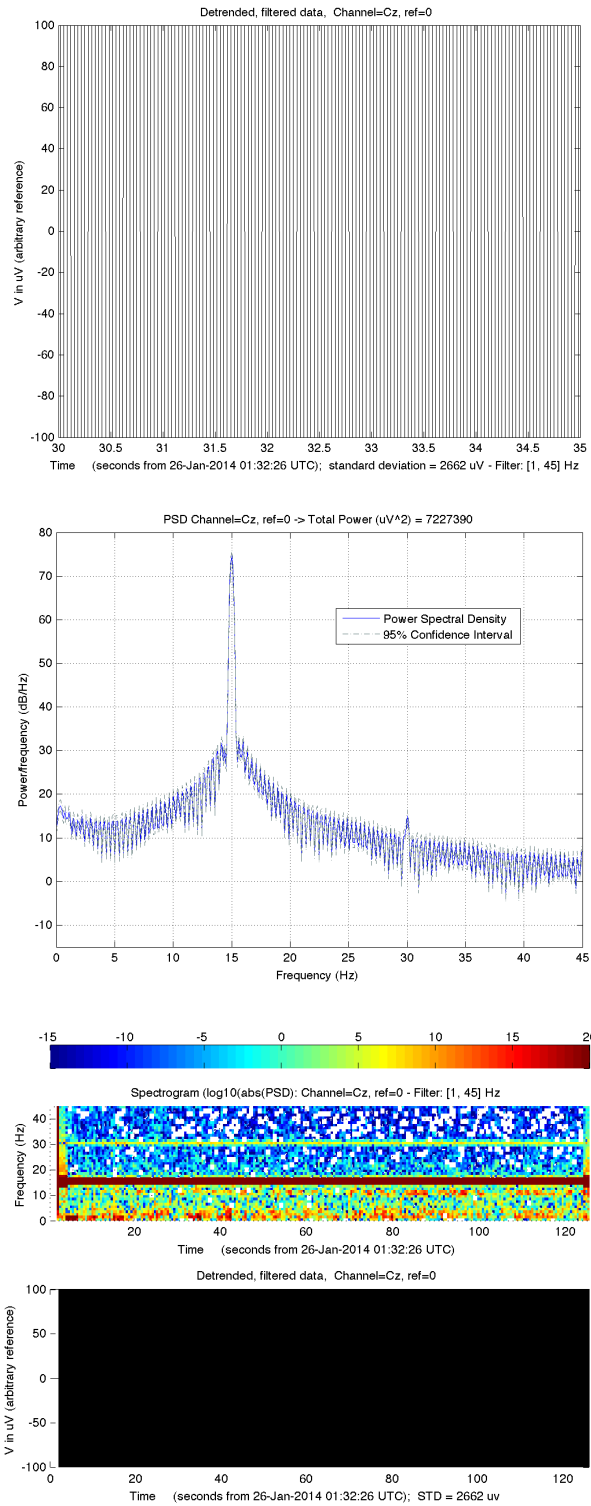
Time signals, spectrograms and Power Spectral Density functions for Cz position before (left) and during stimulation (right). Stimulation amplitude was set to 300 μA (600 μA peak to peak) and its frequency to 6 Hz.

O2**STIM OFF****STIM ON (6 Hz, 300 μ A)**

Time signals, spectrograms and Power Spectral Density functions for O2 position before (left) and during stimulation (right). Stimulation amplitude was set to 300 μ A (600 μ A peak to peak) and its frequency to 6 Hz.

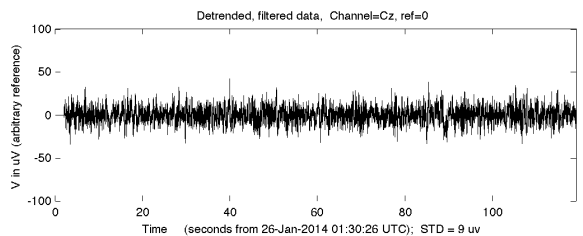
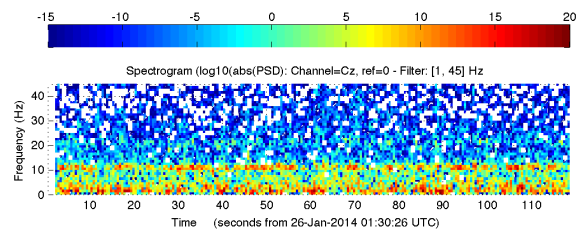
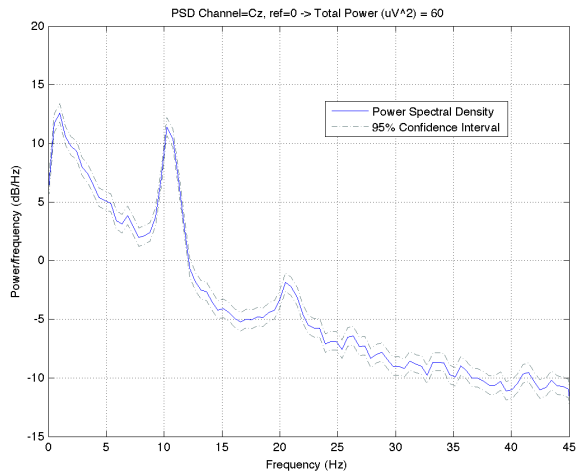
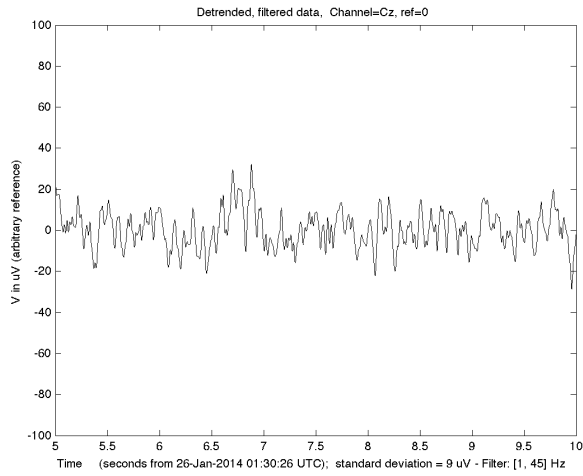
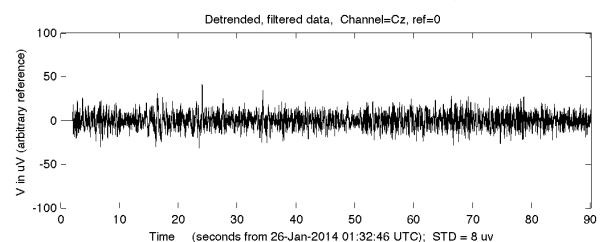
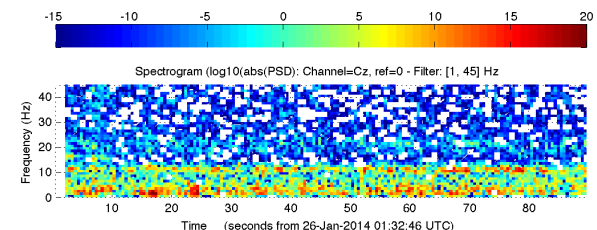
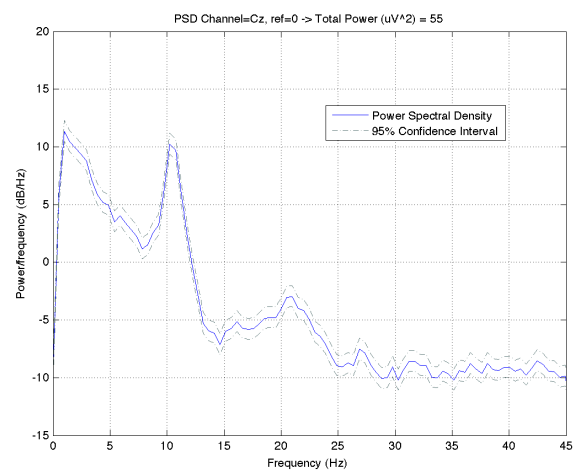
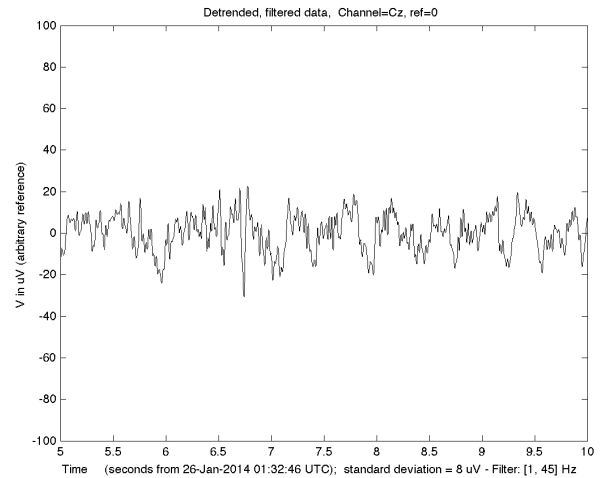


EEG data collected before (top) and during (bottom) during stimulation with a stimulation frequency of 6 Hz and an amplitude of 300 μ A (600 μ A peak to peak). F3 and F4 in are stimulation channels in the figure in the bottom.



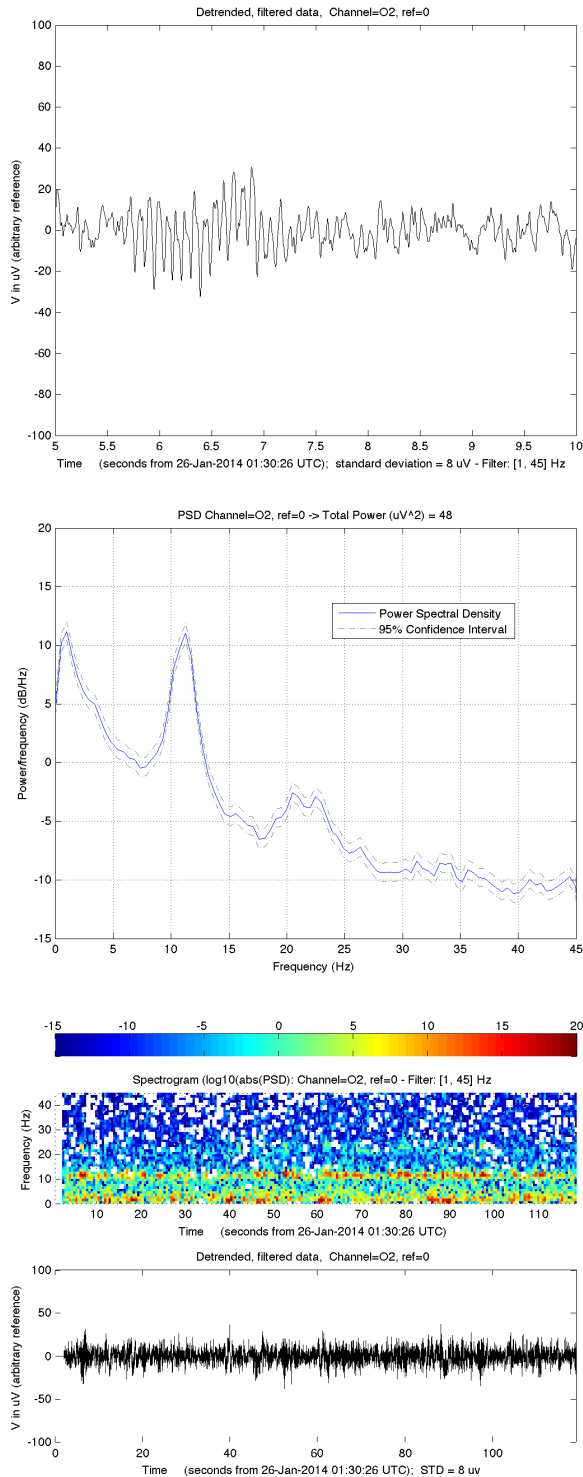
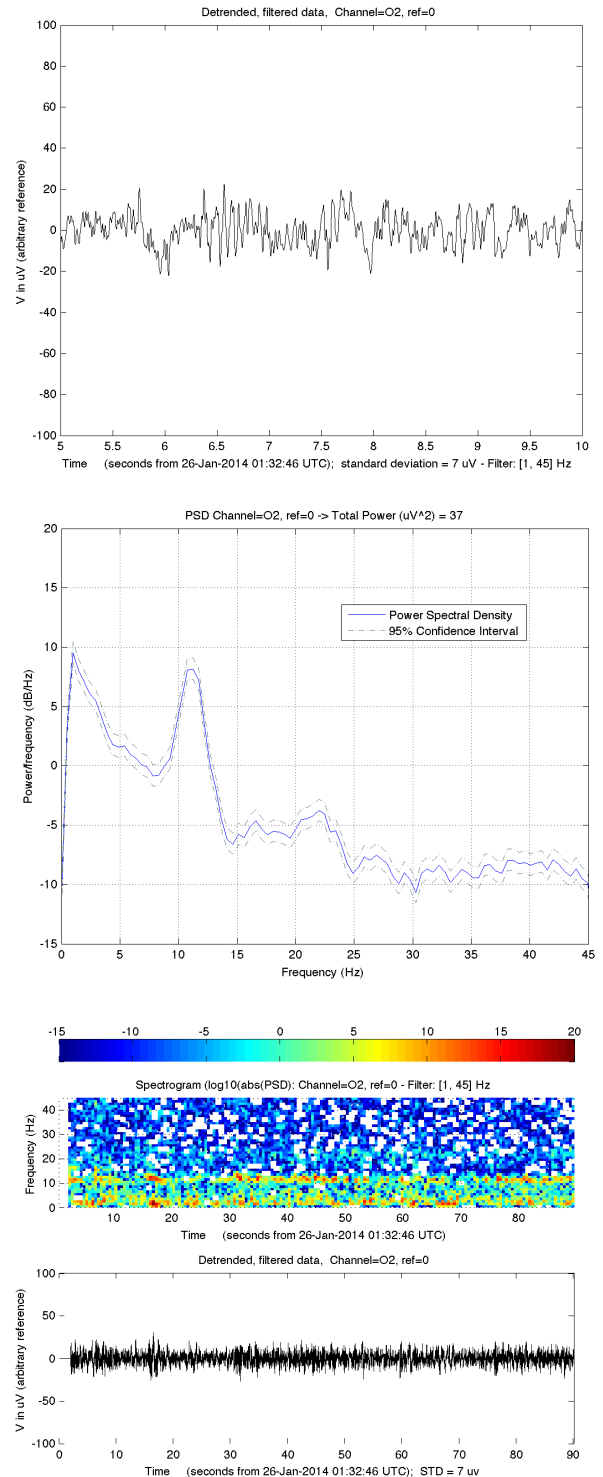
Time signal, spectrogram and Power Spectral Density function for Cz during stimulation at 15 Hz before cleaning the tACS artifact and its harmonics. The signals for the rest of the channels are almost identical. These figures are provided for comparison with the cleaned signals in the following pages.

Cz

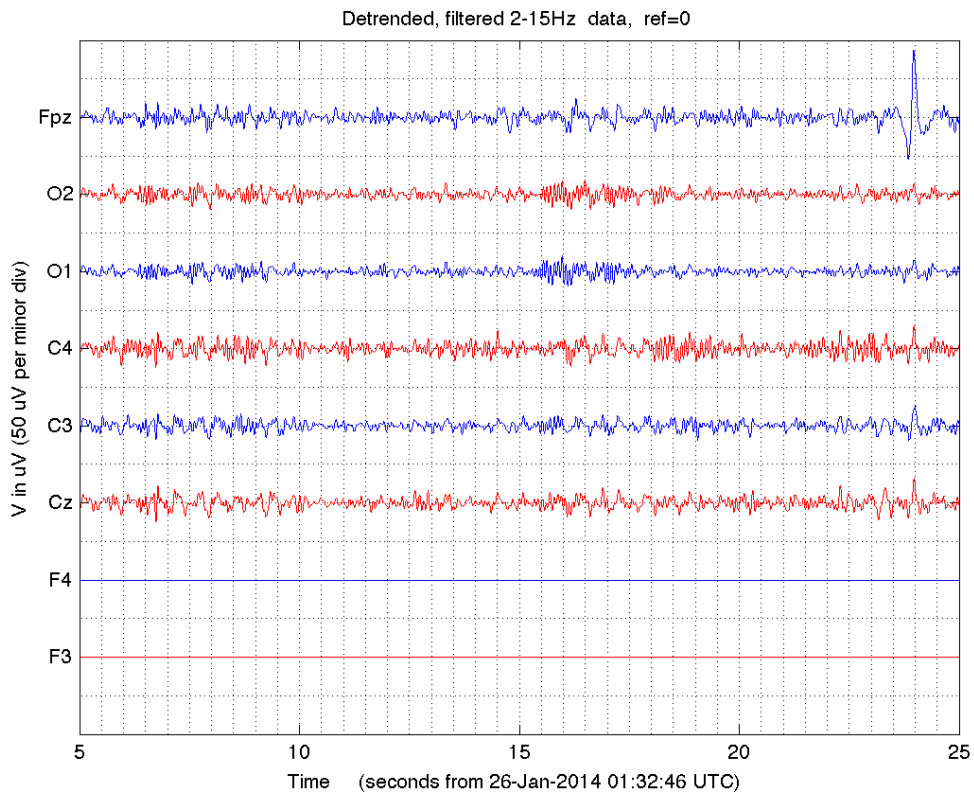
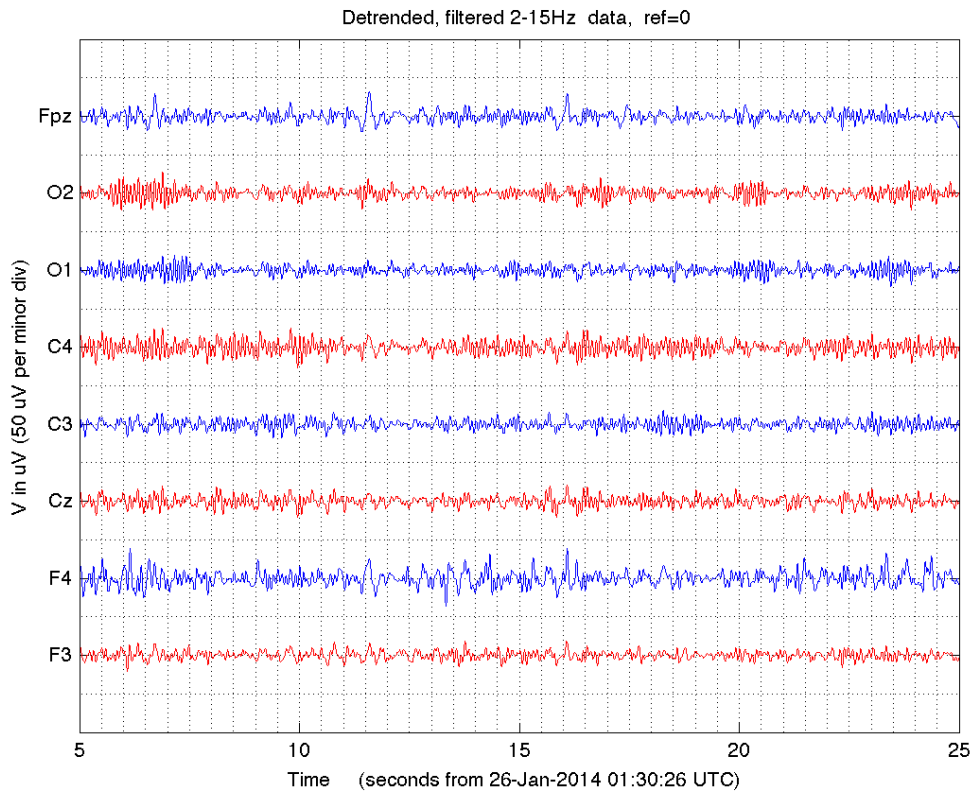
STIM OFF**STIM ON (15 Hz, 500 μ A)**

Time signals, spectrograms and Power Spectral Density functions for Cz position before (left) and during stimulation (right). Stimulation amplitude was set to 500 μ A (1000 μ A peak to peak) and its frequency to 15 Hz.

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STIM OFF**STIM ON (15 Hz, 500 μA)**

Time signals, spectrograms and Power Spectral Density functions for O2 position before (left) and during stimulation (right). Stimulation amplitude was set to 500 μA (1000 μA peak to peak) and its frequency to 15 Hz.



EEG data collected before (top) and during (bottom) during stimulation with a stimulation frequency of 15 Hz and an amplitude of 500 μ A (1000 μ A peak to peak). F3 and F4 in are stimulation channels in the figure in the bottom.